

# Space Charge and Simulation

A Summary of the XIIth ICFA Beam Dynamics  
Mini-Workshop

held at Trinity College, Oxford, England

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# Workshop Arrangements

- <http://www.isis.rl.ac.uk/AcceleratorTheory/workshop/workshop.htm>
- Contains all talks (pdf), benchmarking arrangements and codes  
spreadsheet



# Aims of Workshop

- Identify available simulation codes and their capabilities.
- Highlight latest simulation techniques.
- Hear about latest modelling and experimental results for specific accelerators.
- Identify most urgent questions needing to be answered by simulation.
- Check status of benchmarking: codes v. theory, codes v. experiment.
- Set up a “formal” benchmarking programme.
- *No time to discuss: methods of simulation, how codes work, how to calculate emittance growth, problems of too few/too many macroparticles, algorithms for solving Poisson’s equation etc.*

# Codes

- IMPACT (Rob Ryne, Ji Qiang)
  - mainly linac code but with new Marylie developments for modelling rings
- ORBIT (Jeff Holmes, Sarah Cousineau)
  - Rings code developed for SNS
  - 3 versions: ORNL, BNL, Fermilab
- Simpsons (Shinji Machida)
- ACCSIM (Fred Jones)
- Track1d/2d/3d (Chris Prior)
- ESME (Jim MacLachlan) – longitudinal (1D)
- LONG1D (Shane Koscielniak)
- GPT (Pulsar Physics, Bas van der Geer)

# Codes

- GenTrackE (Andreas Adelmann)
- BEST (Hong Qin)
- Micromap (Ingo Hofmann, Giuliano Franchetti)
- WARP (David Grote, Alex Friedman)
- TRACE/WIN (Nicolas Pichoff)
- Parmila, Parmela, Trace3D
  - Well established Los Alamos codes
- PATH (Alessandra Lombardi)
  - Linac, muon ionisation cooling
- VADOR (Eric Sonnendrucker)
  - Vlasov solver



# Simulation of Specific Accelerators

- LANL PSR
  - (Sarah Cousineau) Good agreement with measured beam profiles and ORBIT calculations.
- Fermilab Booster
  - Bottleneck to increased collider luminosity.
- CERN PS
  - Experiments on emittance growth as function of tunes, bunch intensity, bunching factor, RF voltages etc.
- ISIS
  - Systematic programme of measurements and simulations planned.
- UMER
  - Tiny (3.7m diameter) ring dedicated to accelerator physics.

# Benchmarking: Code v. Code

<b>Code</b>	<b>Test</b>	<b>Result</b>
Accsim, Orbit, Simpsons	PSR, KV rms emittance	Good
Orbit, ESME	1D longitudinal	Good
Orbit, Synergia	FNAL booster, multiturn injection, emittance blow up	Discrepancy
Track1D, Long1D, Accsim	1D longitudinal, ISIS, SNS, ESS	Good
Track2D, Simpsons, Orbit	SNS ring modelling Fermilab PD injection	Good
Micromap, Impact	Octupole resonance with space charge	Good

# Benchmarking: Code v. Measurement

<b>Code/Machine</b>	<b>Measurement</b>	<b>Result</b>
Orbit, PSR	Profile	Good
ESME/ Fermilab ESME/CERN PS	1D (long)	Good/fair Good/fair
Micromap/CERN PS	Montague resonance	In progress
Accsim/CERN PSB	1D profile	Fair
Accsim/KEK PS	1D profile	Good
Impact/LANL LEDA	Halo	Discrepancy when mismatched, good when matched
Orbit/FNAL booster	Emittance blow up	Inconclusive
GPT/Felix	Emittance, radiation, profile	Good
BEST/PSR	E-cloud effect	Fair
Track1D/ISIS	1D (long) profiles and loss	Good
Track2D/CERN PSB	Instability/emittance effect	Good

# Benchmarking Programme

- Measured data from CERN PS (R. Cappi)
  - Emittance blow up crossing integer/half-integer resonance
  - Emittance exchange when crossing Montague resonance  $2Q_h - 2Q_v = 0$
- Participants
  - F. Jones (Accsim)
  - A. Luccio (Orbit)
  - J. Holmes, S. Cousineau (Orbit)
  - A. Adelmann (GenTrackE)
  - H. Qin (BEST)
  - I. Hofmann (Micromap)
  - W. Chou (Orbit)
  - J. Qiang, R. Ryne (Impact/Marylie-Impact)

## Codes Spreadsheet

- A detailed spreadsheet listing the codes, their main features, uses, limitations and availability:  
<http://www.isis.rl.ac.uk/AcceleratorTheory>



